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## VITAMINES AND NUTRITION

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SINCE 1912 when Casimir Funk first brought to the attention of the public the hitherto unknown dietary essentials under the collective term vitamins, nutrition experts have felt that they had something tangible to investigate—something the importance of which it was necessary to prove or disprove. As experimentation revealed symptoms attributable to vitamin deficiency, the general public, ever easily impressed by matters unexpected, and matters so vital as to revolutionize the conception as to what constitutes an adequate diet, soon became alarmed. At present it is probably not overstating the situation when it is said that the previously considered all-important attributes of an adequate ration, such as sufficient protein, calories and salts, have probably been slighted by the sudden interest taken in vitamins. Nor is this so very remarkable. Certainly no individuals have been more impressed with the important rôle that vitamins have in the diet than the investigators engaged in this field of nutrition. Only a few years ago students were taught that the body needed energy, to be furnished by carbohydrates and fats, protein, to be furnished by proteins, and inorganic elements, to be furnished by ash. These, together with water, were supposed to constitute the sum total of the dietary requirements of the animal body. Imagine the surprise and chagrin of the nutrition experts when it was found impossible to support the life of an experimental animal, such as the rat, on a ration compounded from these elementary *highly purified* food stuffs. Lack of palatability resulting in insufficient consumption was given as the reason. “How,” was it asked, “can an animal maintain itself when the lack of taste to the food leads to loss of appetite?” “Our naturally occurring foods contain esters and ethers which induce better consumption and therefore maintenance.” But, on investigation, it was found that a great substantial variation in the taste of the ration by the addition of flavoring extracts of great variety in kind and amount did not improve the nutrition of the animal. Not until there were added small amounts of certain plant or animal tissues or their extracts—now known



1. A pigeon showing a neck spasm in an acute attack of avian beri-beri (polyneuritis) resulting from the consumption of a ration deficient in water-soluble vitamine.

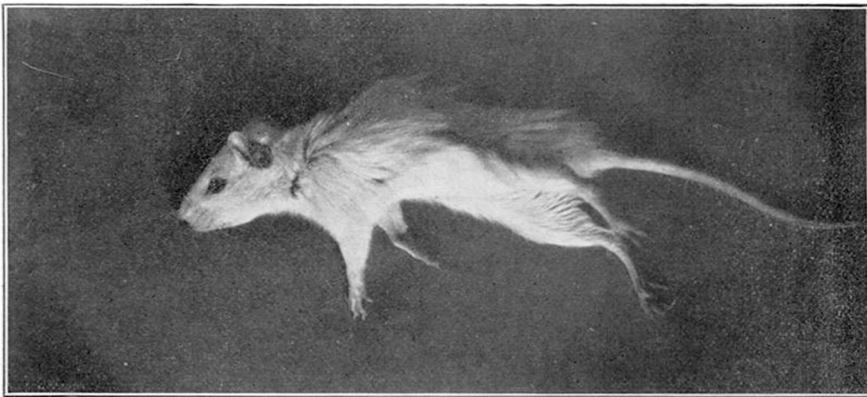
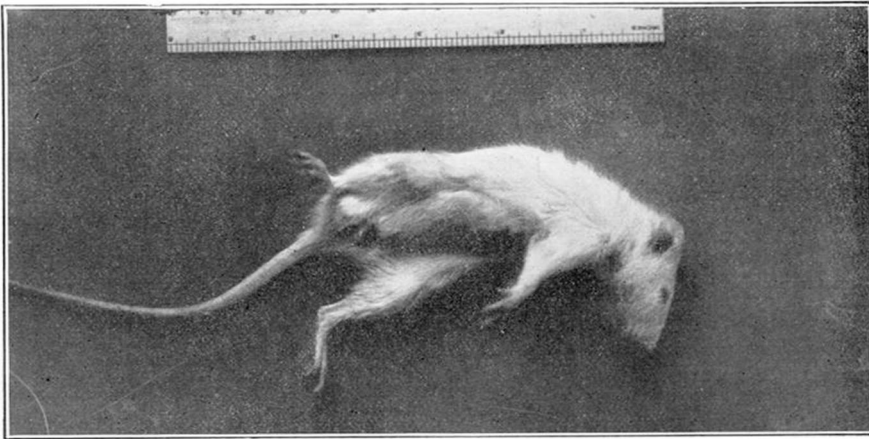
to furnish the vitamines—was it found possible to induce normal nutrition. Certainly the public is to be excused, if, as the result of the enthusiasm of the investigator, it shows undue concern over the vitamine content of the daily diet.

Let us analyze the situation more minutely from the experimental standpoint, so that we can comprehend what is definitely known in regard to vitamines, what physiological disturbances are to be expected if our diet is deficient in them and what with our present mode of living is the probability of a deficiency.

Generally it would be inferred from the term, as Funk implied, that vitamines are substances of an amine nature concerned with vital phenomena. Though certain derivatives of ammonia have been shown to have some of the properties of vitamines, yet of their amine nature there is conclusive proof. Of their relation to vital phenomena there is absolutely no question. Physiologically, vitamines can be divided into at least two types. Both are soluble in water, but only one is soluble in fats. This difference in properties has led to their characterization, respectively, as a water-soluble vitamine and as a fat-soluble vitamine. Though possible, yet in the light of present information it can not be considered probable that either type consists of more than one active component. Chemically, in even an approximately pure form, both vitamines are entirely unknown. Without either kind in the diet, animal life, at least that high in the genetic scale, is impossible.

Curiously enough, the observations of symptoms indicative

of a lack of the water-soluble vitamine in the dietary were made on man himself. In the far east, especially in the Malay peninsula, in the Philippines and in Japan, there has been prevalent a disease known as beri-beri. It is characterized by a loss in weight with muscular atrophy, contracture or paralysis. It may run a rapid course, ending in sudden death, due to heart failure, or it may take on a chronic form. On post mortem there is evidence of more or less edema and extensive degeneration of nerve elements. Though these cases were of quite frequent occurrence, economically this disease was first brought to the attention of the civilized world when, during the Russian-Japanese war, a considerable portion of the Japanese army was incapacitated by its ravages. Fortunately,

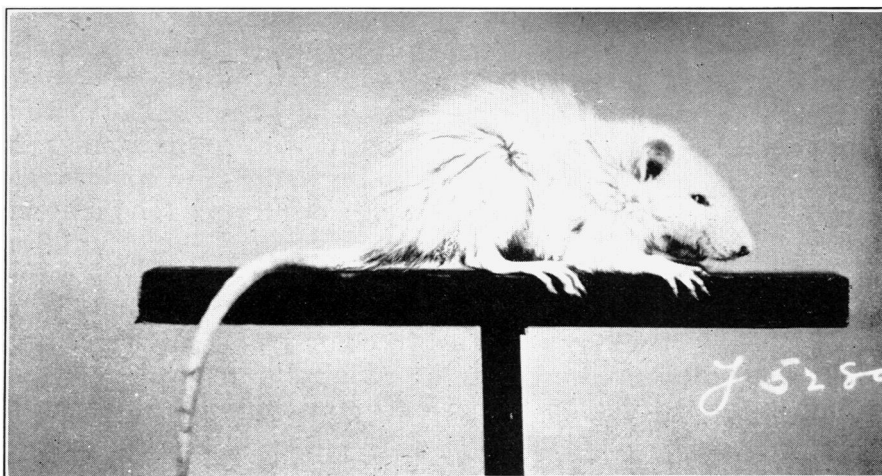


2. A young female albino rat suffering from polyneuritis due to a deficiency in its diet of the water-soluble vitamine. Note the abnormal curvature of the back and especially in the one photograph an extreme spasticity. This rat should normally have weighed 120 grams; its actual weight was 54 grams. A rat in this condition without treatment will usually die in 10 to 24 hours.

by this time, experimental investigation had already indicated suitable prophylactic treatment, and prompt improvement and final prevention were brought about by providing for more variety in the ordinary oriental diet of white rice and fish.

Beri-beri was put upon an experimental basis when Eykman, a Dutch investigator working in the East Indies, observed that birds fed exclusively on white rice developed symptoms resembling those of human beri-beri. At first they consume rice readily, but anorexia soon ensues. After a period of a few weeks the onset of the disease is indicated by a tenseness of the muscles of the crop; usually then in the course of twenty-four to thirty-six hours more pronounced symptoms appear. When the bird is entirely at rest these may not be so evident, except for a slight unsteadiness of the head, but upon the slightest excitation the head may be suddenly thrown backwards, the feet forwards and the wings flapped violently as the bird makes an effort to regain its balance. These movements cause it to tumble over and over. In these spasms certain muscles are so exceedingly tense that violent restraint may lead to injury. Not all birds in an experimental lot may show these symptoms, variations in the symptoms being caused by the kind of nerve elements affected in the degenerative processes. Some birds may take on a so-called chronic form where the progress of the disease is so slow that death results primarily from starvation. All acute cases can be promptly relieved by the administration of extracts containing the water-soluble vitamine. Complete alleviation of all symptoms in most violent cases have been seen to result three to five hours after the injection of a few milligrams of a concentrated water-soluble vitamine preparation. A bird in violent convulsions often will preen itself, coo, and strut around in its cage six to ten hours after such treatment.

Experimentally, a nutritional polyneuritis can also be induced in the rat. A lack of the water-soluble vitamine in the ration of the growing rat will soon lead to cessation of growth, then to rapid loss in weight and finally to spasms which terminate in death. The oral administration of the water-soluble vitamine, if the respiration has not become too feeble, will terminate the violent symptoms and lead to complete recovery. If the administration of the vitamine is continued, the animal will resume eating and rapidly regain its health and begin to grow. In certain ways the water-soluble vitamine stands in different relations to the reproducing animal than other food constituents. When the ration of a nursing animal is poor in



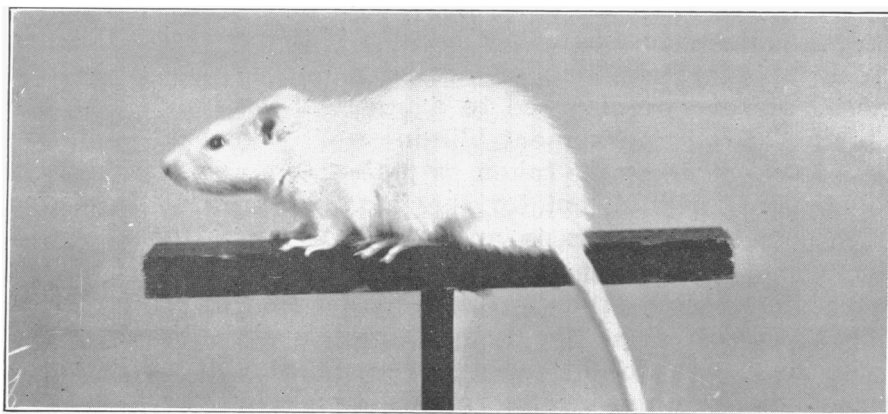
3. The same rat 23 hours later after the oral administration of an alcoholic extract of 3.4 grams of wheat embryo. It was now able to sit quietly in normal position and resume eating its former vitamine-deficient ration.

good proteins or poor in certain mineral elements such as lime, normal milk will be produced at the expense of body tissue. Such a process, which sooner or later results in the depletion of the reserve of the mother, gradually manifests itself in her appearance. When, on the other hand, the ration is low in its content of water-soluble vitamine the mother may maintain herself in fine condition and the young will grow, but may suddenly become neuritic and soon succumb.

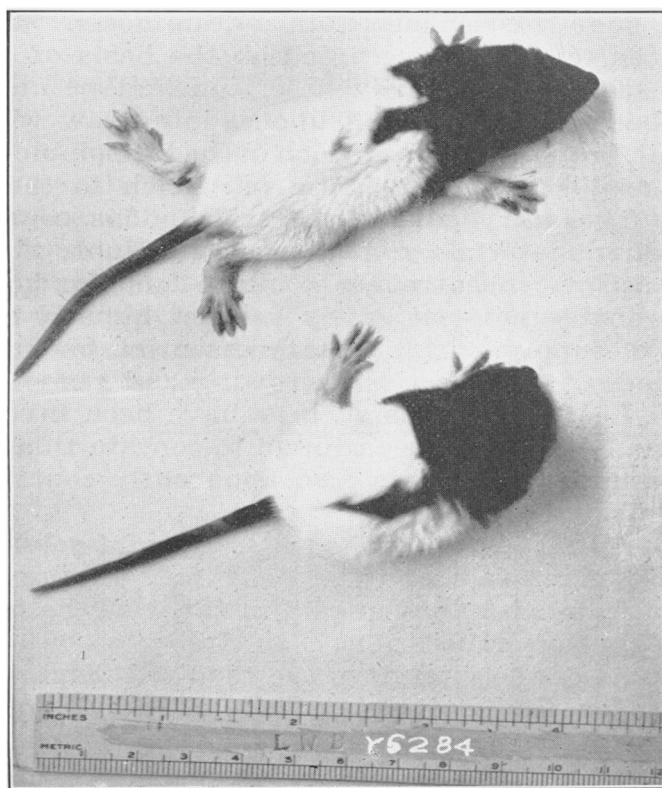
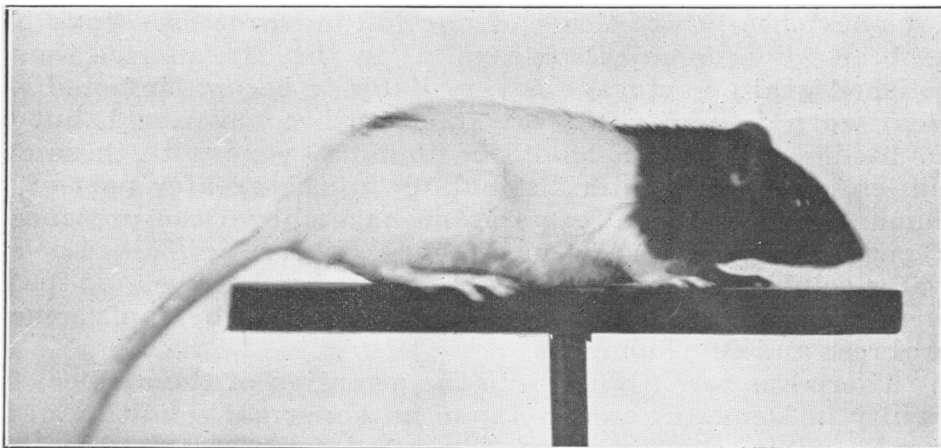
Deficiency of a ration in the fat-soluble vitamine is indicated by symptoms not so specific or so dramatically manifest. A young rat will fail to grow, and a mature rat will fail to maintain itself just as would happen if there were a deficiency of suitable protein, ash or available energy, but in addition these rats are predisposed to a purulent conjunctivitis which usually leads to permanent blindness. So general is this condition that it might be taken as pathognomonic of this dietary deficiency if it were not for the fact that an indistinguishable form sometimes occurs in animals on other rations. In addition, Osborne and Mendel have found that their rations deficient in the fat-soluble vitamine induced the formation and deposition of calculi along the urinary tract. It is barely possible that these two conditions are related, irritation in the eye socket, due to abnormal secretions, preparing the field for the conjunctivitis. That it is an infection is indicated by its response to proper medication.

As these two forms of dietary deficiency can be easily dem-

onstrated experimentally in the laboratory, one may well ask the question—what is the probability that certain cases of recognized or even unrecognized malnutrition in man may be due to an avitaminosis? With respect to beri-beri under ordinary conditions the danger is not very great, if at all existent. It is only when man so modifies the type ingredients in his diet as to depart from the character of *naturally* occurring food materials that beri-beri has ever been known to occur. The oriental suffered from this malady when he began to demand, for esthetic reasons only, that the prepared rice in his diet should be white. As the hulled rice kernel varies in color from a light yellow to almost black, he proceeded by a crude milling process to grind off this variously pigmented pericarp and thus obtained his white or polished rice. Though his esthetic desires were satisfied, his source of water-soluble vitamins had been dangerously reduced in amount; sporadic outbreaks of beri-beri became common. A similar condition of affairs has been reported in Newfoundland where an almost exclusive subsistence on patent wheat flour during a period of scarcity of other foods caused beri-beri. In the milling process where the aleurone layer and embryo of seeds are removed most of the vitamins are removed as well. It is timely to question the wisdom of many of our food-manufacturing processes not only from the standpoint of removal of valuable salts and proteins, but of vitamins as well. Why feed many of the most vitally necessary food constituents having their origin in the manufacture of our food in superabundance to our stock for animal and milk production and feed ourselves on what may look better



4. The same rat 23 days later kept on the same ration, but given daily the residue of an alcoholic extract equivalent to 3.4 grams of wheat embryo dissolved in its drinking water. The rat now weighed 102 grams. At the present time of writing it is in excellent nutritive condition and still gaining rapidly.



5. A female rat and her young raised on a ration rather low in its content of water-soluble vitamins. She became pregnant and raised a litter of four young to a total weight of 66 grams. The nursing young grew rapidly, but suddenly in one day lost 5 grams in weight and showed periods of great excitability. The next day one was found dead, and the others had convulsions as indicated in the cut. Such young invariably develop into normal rats when nursed by a normal rat on a complete ration; otherwise death ensues rapidly.

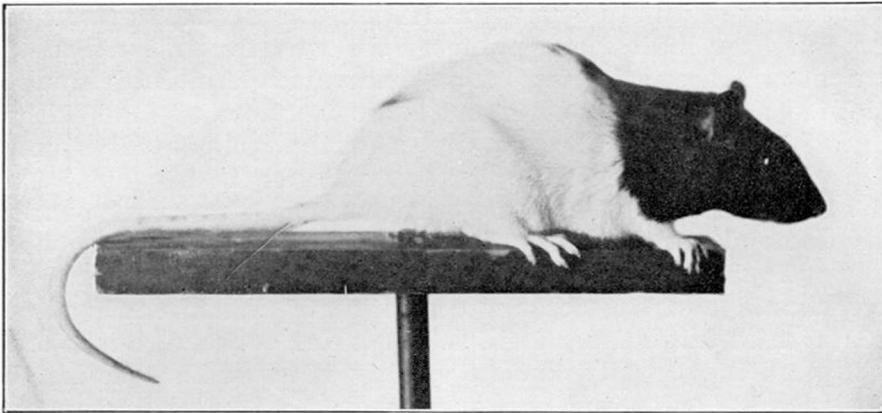


but nourishes less? Some of our milling processes have been adopted for economical reasons, as in the case of rice the unpolished grain on storage is very liable to become infected with meal worms and its fats are liable to become rancid, but undoubtedly other means could be found to cope with these difficulties. All food materials making up the greater part of the human dietary so far investigated have shown the presence of a generous amount of the water-soluble vitamine. Lack of water-soluble vitamine undoubtedly has not been one of the determinants which in itself has interfered with man's general progress and development.

There has recently come to the attention of the medical fraternity in Denmark and in Japan an abnormal condition of the eyes, a xerophthalmia, in children fed on pasteurized milk or grain milk-substitutes. Monrad and others have made the suggestion that this is due to an avitaminosis. This hypothesis has been tentatively accepted on the basis of experiments with rats such as previously described and because improvement has been found to result upon adding raw whole milk or cod-liver oil, both of which are rich in the fat-soluble vitamine, to the previous diet. Butter fat is very rich in the fat-soluble vitamine. The dairy cow in the tremendous consumption of rough feeding materials rich in the fat-soluble vitamine performs the act of concentrating it in the food for her offspring.

Man probably can not safely restrict himself to grains as his source of supply of this dietary essential, but needs to supplement them with the actively growing and assimilating parts of plants. Leafy materials such as have been investigated up to the present time have been found to contain this vitamine in large amounts. Some roots also apparently contain considerable amounts.

Because butter fat is very rich in this fat-soluble vitamine and because plant fats and the body fats of animals contain but little of it, much has been said in favor of the use of butter instead of butter substitutes. In full realization that but small amounts of the vitamins are required it must be remembered, however, that butter is wholly absent from the dietary of some and at most constitutes but a small part of the total of food stuffs consumed by most people and while little is known definitely of the fat-soluble vitamine content of other foodstuffs, yet enough is known to indicate that sufficient amounts to satisfy all requirements of the body can be carried by other food materials. It is not necessary to value milk especially on the basis of its fat-soluble vitamine content when it is remembered

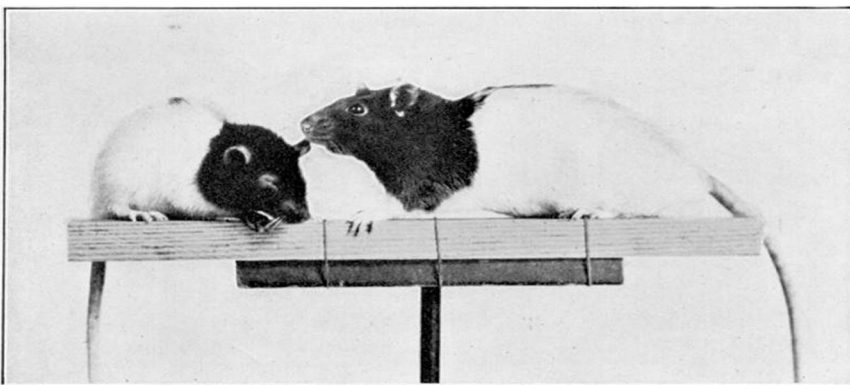


6. The same rat 77 days later after having had two more litters, neither of which she kept alive longer than a few days. Though slightly longer haired she weighed 25 grams more and was in good condition. Rearing of the young is a process more exacting in its requirements than either growth or reproduction.

that as a source of protein for the animal it has no equal. For this we have no substitute, for it as a source of fat-soluble vitamine we have.

At one time, there was a tendency to associate etiologically other conditions of malnutrition, such as scurvy and rickets, with a deficiency of specific vitamins. Evidence so far presented does not support this contention. These diseases are undoubtedly associated with a faulty intestinal condition not directly referable to an avitaminosis.

In the present emergency in the economic food situation, it



7. Two male rats of the same age. The one on the right—a normal rat—received a sufficiency of the fat-soluble vitamine in its ration; it weighed 262 grams. The one on the left received but little of the fat-soluble vitamine; it weighed 109 grams. Note the inflammation of the eyes and the incrustation of the ears to which rats on a ration deficient in the fat-soluble vitamine are subject. Both conditions, if not too far advanced, can be improved by suitable medication.

is the duty of all students of nutrition to scan the horizon very carefully for indications pointing the way for rational modifications in the selection of nutriments. An individual so adapted as to be able to digest large amounts of food without digestive or other organic disturbances undoubtedly guards himself against a deficiency of any nutrient in his diet. This, in considerable measure, may account for the great capacity for work shown by some heavy eaters. On the other hand, many people are undoubtedly limited in their performance due to a shortage of a necessary constituent. When the food consumption is large there is little cause for concern, but when it is limited in quantity and in variety it is well to realize that any one of the factors, viz., vitamins, protein, salts or energy may limit a man's capacity for work. It might be said that it is unfortunate that man is not gifted with a sense of perception indicating to him the specific dietary needs of his body. He is either hungry or satisfied and ultimately he feels well or unwell. It is sufficient to say that vitamins are indispensably necessary in the diet, but for normal nutrition, if the individual has the opportunity to select his foods as he desires, lack of vitamins should undoubtedly give no greater cause for concern than lack of suitable proteins or salts. There is cause to look forward with considerable anticipation to the economic results which are bound to come with a fuller knowledge of what constitutes the valuable dietetic properties of many food materials individually and in various combinations.